

Bus description

PSD4xx positioning system – POWERLINK

ETHERNET 
POWERLINK



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The instruction manual is part of the product. Please read this manual carefully, follow our instructions, and pay special attention to the safety information provided. This instruction manual should be available at all times. Please contact the manufacturer if you do not understand any part of the instructions.

The manufacturer reserves the right to continue developing this device model without documenting such development in each individual case. The manufacturer will be happy to determine whether this manual is up-to-date.

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1 General

This bus description is to be used for the commissioning and integration of the drive into a field bus system.

Technical data for the electrical connections of your drive can be found in the electrical connector and pin assignment description on the website:

www.halstrup-walcher.de/technicaldocu

Please search for "PSD" and select your type, click on "Instruction manuals" and download the "connector and pin assignment" offered for your bus system.


1.1 Explanation of symbols


The device has been designed and tested to ensure its safety. However, it may still be dangerous if used inappropriately. Precautions must be taken to prevent the device being used incorrectly by mistake.

The following warnings are used in this instruction manual:

 DANGER!	DANGER! Indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented.
 WARNING!	WARNING! Indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented.
 CAUTION!	CAUTION! Indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented.
NOTICE	NOTICE Indicates a potentially harmful situation, which may lead to material damage if not prevented.

2 Start-up

 WARNING!
<p>The permissible rated voltage varies by device. Before connecting the power supply, you must ensure that the rated voltage specified on the type label (24 V DC or 24..48 V DC) matches the voltage source provided. An incorrect supply voltage will damage the drive.</p>
<p>Risk of injury if used inappropriately. The device must be installed by trained technical personnel.</p>
<p>Risk of burns due to hot drive. The drive can become very hot during operation. Allow the drive to cool before touching it.</p>
<p>Risk of crushing due to rotary movement. Do not reach into the working area of the drive when it is still turning. The user/operator must ensure appropriate protective measures are taken.</p>
<p>Incorrect assembly can lead to the destruction of the drive.</p>
<p>Check that the supply lines are not pinched or crushed.</p>
<p>Lay the supply lines according to the general and specific local assembly regulations. If the supply lines have not been delivered together with the device, please select suitable cables for the application. Do not operate the direct drive if the supply lines are noticeably damaged.</p>
<p>Risk of injury. High contact voltages can occur in the case of malfunctions. This can be prevented by grounding.</p>

 CAUTION!
<p>The drive must be protected against excessive heating. The user/operator must ensure appropriate protective measures are taken.</p>
<p>Never apply force to the housing of the drive, e.g. for supporting weight.</p>

2.1 Setting the device address

The device address is configured by means of two rotary switches. One switch defines the tens digit, the other defines the unit's digit.

If the address of the rotary switch is set to 0, the address stored in SDO #2026 is used.

2.2 Switching on the device

After connecting the supply voltage, you can begin positioning or manual runs immediately.

You can find information about installing the drive as well as electrical connections and pin assignments at the following link: www.halstrup-walcher.de/technicaldocu

Please search for "PSD" and select your type, click on "Instruction manuals" and download the "connector and pin assignment" offered for your bus system.

2.3 Generating the delivery state (without the control unit)

The drive can be reset to the delivery state even if no control unit is present.

Generate the delivery state as follows:

- 1) Separate the device from the electrical power supply.
- 2) Set the address switches to 98.
- 3) Switch on the device (control unit and motor voltage).
- 4) The yellow LED now flashes for 10 seconds at 10 Hz. If, during this time period, the address is set to 99, the drive will reset all parameters to the delivery state, save this setting and bring the axle to the mid-position.
- 5) Set the address switch to 00 in order to complete the delivery state.
- 6) Switch the device off.

The 10-second period will be ended earlier if any communication is established.

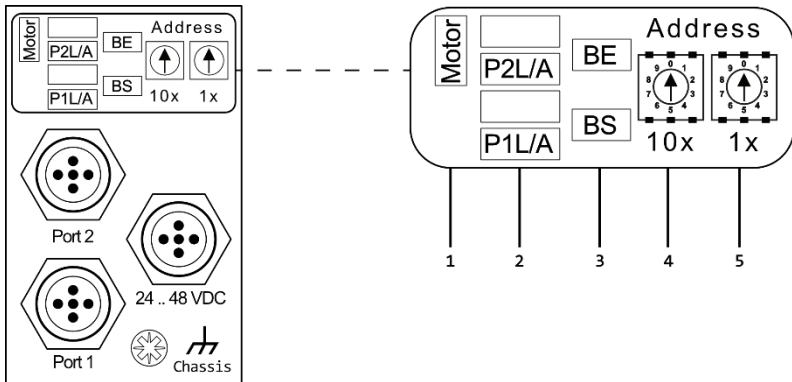
3 Description of Powerlink

3.1 Ethernet Powerlink interface (IEC 61158-6-13)

The Ethernet Powerlink is a real-time protocol for standard Ethernet realized according the EPSG standard 301, version 1.2.0:

One transmit and one receive SDO per device
One asynchronous transmit and receive PDO, active by default

3.2 Status LEDs



The following LEDs are located under the sealing plug:

1	V_Motor	Yellow LED = Motor supply voltage
2	P1L/A	Yellow LED = not used Green LED = Link/Act
	P2L/A	Yellow LED = not used Green LED = Link/Act
3	BS	Red/Green Duo-LED = Signals the CN cycle state
	BE	Red/Green Duo-LED = Signals an error
4	X10	Address switch x10
5	X1	Address switch x1

Meaning of the LEDs:

Yellow LED motor supply voltage (V_Motor)	
Off	Motor voltage too low or too high
On	Motor voltage is OK
Flashing at 0.5 Hz	Motor voltage is OK and drive is in the delivery state

Each of the ports (P1/P2) has a green LED for the “Link” the “Activity” state:

For each port (P1/P2), the following states are possible:	
Off	The device has no link to the Ethernet
On	Link: The device is linked to the Ethernet, but does not send/ receive Ethernet frames
Flickering (10 Hz)	Activity: The device is linked to the Ethernet and sends/receives Ethernet frames
Flickering (irregular intervals)	Activity: The device is linked to the Ethernet, low Ethernet activity

The red/green Duo-LED (BS) signals the CN cycle state:	
Off	Slave initializing
On (green)	Slave is in ‘Operational’ state
Single flashing green at 0.8 Hz	Slave is in ‘PreOperational 1’ state
Double flashing green at 0.6 Hz	Slave is in ‘PreOperational 2’ state
Triple flashing green at 0.5 Hz	Slave is in ‘ReadyToOperate’ state
Flickering green at 10 Hz	Slave is in ‘Basic Ethernet’ state
Blinking green at 2.5 Hz	Slave is in ‘Stopped’ state

The red/green Duo-LED (BE) signals an error:	
Off	Slave has no error
On (red)	Slave has detected an error

3.3 Table of entries implemented from object dictionary

Designation	Index no.	Function	Range of values	Backup	De-livery state	R/W
Device type	1000	Device type	32 bit		0	R
Error register	1001	Error register according CiA DS 301	8 bit			R
Error history	1003	Sub-Index 0: number of current entries	8 bit	no	0	R/W
		Sub 1...254: error entries (latest entry in sub 1)	160 bit			R
Manufacturer software version	100A	denotes the software of the Powerlink drives, when being read the string "PSD4xxIE/PL" is given back	String			R
Identity	1018	Sub index 0: No. of indices (= 4)	8 bit		4	R
		Sub 1: Vendor-ID (= 0x000002D8)	32 bit			R
		Sub 2: Product code (=0x10)	32 bit			R
		Sub 3: Revision number (= 0)	32 bit			R
		Sub 4: Serial number (= 0)	32 bit			R
Receive PDO 1 communication parameter	1400	Sub index 0: No. of indices (= 2)	8 bit	no		R
		Sub 1: Node ID (=0; 0...239)	0...0 8 bit			R/W
		Sub 2: Mapping Version (=0)	8 bit			R
Receive PDO 1 mapping	1600	Sub index 0: No. of indices (= 2)	2...2 8 bit	no	2	R/W
		Sub 1: 0x0010.0000.0000.2024 Sub 2: 0x0020.0010.0000.2001	64 bit 64 bit			R R
Transmit PDO 1 communication parameter	1800	Sub index 0: No. of indices (= 2)	8 bit	no		R
		Sub 1: Node ID (= 0; 0...239)	0...0 8 bit			R/W
		Sub 2: Mapping Version (= 0)	8 bit			R
Transmit PDO 1 mapping	1A00	Sub index 0: No. of indices (= 3)	3...3 8 bit	no	3	R/W
		Sub 1: 0x0010.0000.0000.2025	64 bit			R
		Sub 2: 0x0010.0010.0000.2030	64 bit			R
		Sub 3: 0x0020.0020.0000.2003	64 bit			R
General purpose	2000	Sub Index 0: No. of indices (= 10)	8 bit	yes		R
		Sub 1...Sub 10	32 bit			R/W

Designation	Index no.	Function	Range of values	Backup	De- livery state	R/W
Target value	2001	Target position in 1/100 mm (for a 4 mm spindle and default values of numerator SDO #2010 and denominator SDO #2011). This value can only be written in the "pre-operational" state.	±31 bit	no	0	R/W
Actual value	2003	Current actual position in 1/100 mm (for a 4 mm spindle and default values of numerator SDO #2010 and denominator SDO #2011). Writing to this index number causes the current position to be "referenced" to the transferred value Writing is only possible at standstill	±31 bit	no		R/W
Referencing value	2004	Correction factor for the target, actual and end limit values. Writing only possible when at a standstill.	±31 bit	yes	0	R/W
Drag error	2005	reserved				
Positioning window	2006	Permissible difference between target and actual values for the "target position reached" bit in 1/100 mm (for a 4 mm spindle and default values of numerator and denominator) The maximum setting value changes according to the same factor as the resolution. Writing is only possible at standstill	1...100 Equals 0.0025... 0.25 rotations 16 bit	yes	2	R/W
Position scaling, numerator	2010	These values allow you to apply any resolution to the drive that you wish.	1...10,000 16 bit	yes	400	R/W

Designation	Index no.	Function	Range of values	Backup	De- livery state	R/W
Position scaling, denominator	2011	For a numerator factor of 400, the spindle pitch/resolution is stated in the denominator factor e.g.: Spindle pitch 1.5 mm with resolution 1/100 mm: numerator = 400, denominator = 150 Writing is only possible at standstill	1..10,000 16 bit	yes	400	R/W
Target speed for positioning run	2012	Maximum speed to be used for positioning runs value in 1/min	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Target speed for manual run	2013	Maximum speed to be used for manual runs value in 1/min	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Maximum torque	2014	Applies after the end of the start-up phase (during the start-up phase, the value of parameter #2018 applies) value in cNm	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Upper limit	2016	Maximum permitted target position Permissible values: (upper mapping end -1,200 ... 1,611,600 * numerator/denominator) For models with an auxiliary gearbox, the range of values is reduced in accordance with the gear ratio. Writing is only possible at standstill	±31 bit	yes	See chap. 3.4	R/W
Lower limit	2017	Min. permitted target position Permissible values: (upper mapping end -1,200 ... 1,611,600 * denominator/numerator) For models with an auxiliary gearbox, the range of values is reduced in accordance with the gear ratio. Writing is only possible at standstill	±31 bit	yes	See chap. 3.4	R/W

Designation	Index no.	Function	Range of values	Backup	De-livery state	R/W
Maximum start-up torque	2018	Value in cNm	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Time period for start-up torque	2019	Time period during which the max. start-up torque (SDO #2018) is applied value in ms	10...1,000 16 bit	yes	200	R/W
Speed limit for aborting run	201A	Value in % of the target speed	30...90 16 bit	yes	30	R/W
Time elapsed until speed falls below speed limit for aborting run	201B	Value in ms	50...500 16 bit	yes	200	R/W
Acceleration	201C	Value in 1/min per second	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Deceleration	201D	Value in 1/min per second	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Length of loop	201F	Minimum number of increments, in which the drive runs to a target in a specified direction. Value in increments (0 → no loop) The sign determines the direction of the loop: positive → reference loop to larger values; negative → reference loop to smaller values Writing is only possible at standstill.	0.025... 10 rotations or -0.025... -10 rotations or 0 ±31 bit	yes	-250	R/W

Designation	Index no.	Function	Range of values	Backup	De- livery state	R/W
Control word	2024	Bit 0: Manual run to larger values Bit 1: Manual run to smaller values Bit 2: Transfer target value Bit 4: Release: the axle will only run if bit is set Bit 6: Run without a reference loop Bit 13: Toggle bit Bit 14: Error Acknowledge All other bits are reserved and must be set to 0 This value can only be written in the "pre-operational" state.	16 bit	no	0	R
Status word	2025	Bit 0: Target position reached Bit 1: Reserved Bit 2: Toggle bit Bit 3: Reserved Bit 4: Power supply to motor available Bit 5: Positioning run aborted Bit 6: Drive is running Bit 7: Max temp. exceeded Bit 8: Run in opposite direction to loop Bit 9: Error Bit 10: Positioning error (blocking) Bit 11: Manual rotation Bit 12: Incorrect target value Bit 13: Power was unavailable to motor Bit 14: Positive range limit Bit 15: Negative range limit	16 bit	no		R
Address	2026	User Device Address Write: When writing, the value is only applied after saving (SDO #204F) and performing a restart. This value is only used if the address switches are set to 0.	1...239 16 bit	yes	0	R/W

Designation	Index no.	Function	Range of values	Backup	De- livery state	R/W
Upper mapping end	2028	Definition of the positioning range relative to the absolute value encoder Permissible values: (actual position + 3 rotations) ... (actual position + 4,029 rotations). Writing is only possible at standstill.	±31 bit	yes	102,400	R/W
Maximum holding torque	202B	Holding torque at standstill in cNm (after the phase "max. holding torque at end of run")	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Direction of rotation	202C	0: Clockwise rotation to larger values 1: Counterclockwise rotation to larger values (when looking at the output shaft) Writing is only possible at standstill.	0 or 1 16 bit	yes	0	R/W
Idle period	202E	Time period for change the direction Value in ms	10...1,000 16 bit	yes	10	R/W
Actual speed	2030	Value in 1/min	±15 bit	no		R
Max. current during last run	2031	Maximum current occurring during the most recent run (the start-up phase, during which the start-up torque applies, see SDOs #2018/2019, and braking phase are not taken into account) value in mA	16 bit	no		R
Actual current	2033	Actual current, in mA	16 bit	no		R
U control	203A	actual supply voltage for the control unit in 0.1 V steps	16 bit	no		R
U motor	203B	actual supply voltage for the motor unit in 0.1 V steps	16 bit	no		R

Designation	Index no.	Function	Range of values	Backup	De-livery state	R/W
UMot limit	203C	Voltage limit for bit 4 of the Status word (Power supply to motor available ¹); in 0.1 V steps A positioning run or manual run is only possible if the motor voltage is higher than the value set here. During the run, the voltage may fall to 17.5 V.	180..240 (up to FW ¹ V10699) 180..480 (from FW ¹ V10700) 16 bit	yes	185	R/W
UMot filter	203D	Average time for motor voltage measurement value in ms	100...1,000 16 bit	yes	100	R/W
Temp. limit	203E	Upper temperature limit in °C	10...80 16 bit	yes	80	R/W
Device temperature	203F	Internal device temperature in °C	16 bit	no		R
Production date	2040	Year and week of manufacture (given as an integer)	YYWW 16 bit	no		R
Serial number	2041	Device serial number	0...65,535 16 bit	no		R
Max. holding torque at end of run	2042	Max. holding torque at end of run Value in cNm	See chap. 3.4 16 bit	yes	See chap. 3.4	R/W
Duration of max. holding torque at end of run	2043	Duration during which the holding torque remains active after the end of the run value in ms	0...1,000 16 bit	yes	200	R/W
Waiting time for brakes (begin of run)	2044	reserved				

¹ Firmware

Designation	Index no.	Function	Range of values	Backup	De-livery state	R/W
Drag error correction	2046	maximum modification of the target speed for drag error correction Writing is only possible at standstill.	0...10 16 bit	yes	4	R/W
Readjustment	2047	Adjustment at standstill 0 → off; 1 → on	0...1 16 bit	yes	0	R/W
Configuration for connection failure	2049	reserved				
Safe position for connection failure	204A	reserved				
Repeat time for safety run	204B	reserved				
Device type	204D	Device type within the PSD range as a string (e.g. "PSD403-18-H")	String			R
Version	204E	Software version number (e.g. 10510)	16 bit			R

Designation	Index no.	Function	Range of values	Backup	De- livery state	R/W
Delivery state	204F	<p><u>Writing a "-6":</u> Resets the drive (corresponds to switching the control voltage off and back on)</p> <p><u>Writing a "-5":</u> Sets the values of all parameters to the delivery state, saves the parameters in EEPROM, then positions the drive in the middle of the measurement range *) (Station name and IP address are not affected)</p> <p><u>Writing a "-4":</u> Sets the values of all parameters to the last values saved by the user, then positions the drive in the middle of the measurement range *) (Station name and IP address are not affected)</p> <p><u>Writing a "-3":</u> Sets the values of all parameters to the delivery state, deletes the station name and IP address and saves the parameters in EEPROM</p> <p><u>Writing a "-2":</u> Sets the values of all parameters to the last values saved by the user, without saving the parameters in EEPROM (Station name and IP address are not affected)</p> <p><u>Writing a "-1":</u> Sets the values of all parameters to the delivery state, without saving the parameters in EEPROM (Station name and IP address remain unaffected)</p> <p><u>Writing a "1":</u> Saves the parameters in EEPROM</p> <p>Writing is only possible at standstill.</p>	-6...-1, 1 ±15 bit	no		R/W

Designation	Index no.	Function	Range of values	Back-up?	De-livery state	R/W
Modulo Mode **)	2053	0 → Modulo function inactive 1 → Run to larger values 2 → Run to smaller values 3 → Shortest way 4 → Run to larger values with blocking zone 5 → Run to smaller values with blocking zone	0..5 16 bit	yes	0	R/W
Upper modulo position **)	2054	Highest position of the modulo range When this position is reached, the actual position jumps to the value [lower modulo position]. value in steps	±31 bit	yes	3,600	R/W
Lower modulo position **)	2055	Lowest position of the modulo range If the actual position falls below this value, it jumps to the value [Upper modulo position - 1]. value in steps	±31 bit	yes	0	R/W
Number of sectors in modulo mode **)	2056	Dependent of the scaling (numerator/denominator, see SDO #2010 and #2011) and the modulo range (see SDO #2054 and #2055). If the modulo mode is active, the value should not exceed the value 10,000 (if necessary, modify the scaling or the modulo range).	16 bit			R
Additional functions **)	2057	The value indicates which additional functions are available. The individual bits indicate the availability of a certain additional function. If the bit is set, the corresponding additional function is available. Bit 0: Modulo mode 0: not available 1: available	16 bit			R

Designation	Index no.	Function	Range of values	Back-up?	De-livery state	R/W
Raw Position of absolute measurement unit (**)	2058	Raw value of actual position (4,096 steps per motor rotation) value range [-2,016 ... 2,016] motor shaft rotations	±31 bit			R

*) The positioning run to the middle of the measurement range can be aborted at any time by setting control word = 0 with SDO #2024 (if state is not "operational") or via the PDO control word.

Furthermore, in "operational" state, the PDO control word is ignored during the positioning run to the middle of the measurement range (unless it changes). Thus, a run to the middle of the range can also be aborted by changing the PDO control word. Run commands issued before the positioning run to the middle of the range will not be automatically resumed after this run has been completed, (i.e. the PDO control word 0x14 and the old target value do not result in the drive moving to this position).

**) The SDOs #2053 to #2058 are available from firmware V1.5.20. For the variants with the option "Modulo function" (i.e. variants with the feature "Software modules" = "M" or "Z"), the modulo function is configured with these SDOs. For the variants without modulo function (i.e. variants with the feature "software modules" = "1", "S" or "P") only the default value can be written, other values are rejected.

3.4 Table of device-dependent min., max. and default values
NOTICE

The operating torque setting is optimised for the nominal rated speed of the respective device model. The more the set speed deviates from the nominal rated speed (1/min), the greater the actual difference between the actual power consumption of the motor circuit and the set value.

Setting the value for the max. holding torque to 0 results in a maximum current consumption by the motor circuit of approx. 50 mA

Device type		PSD 401/411 - 5V	PSD 401/411 - 8H/14H	PSD 403/413 - 8H/14H	PSD 422/432 - 8V	PSD 422/432 - 8H/14H
Name	Index no.	Range of values Delivery state				
Upper mapping end *)	2028	806,400	806,400	198,498	806,400	806,400
Upper limit *)	2016	805,200	805,200	197,298	805,200	805,200
Lower limit *)	2017	-805,200	-805,200	-197,298	-805,200	-805,200
Target speed for positioning run	2012	1...800 200	1...500 200	1...250 50	1...1,000 200	1...500 200
Target speed, manual run	2013	1...800 70	1...500 70	1...250 17	1...1,000 70	1...500 70
Acceleration	201C	1...5,000 1,000	1...5,000 1,000	1...1,250 250	1...5,000 500	1...5,000 500
Deceleration	201D	1...5,000 2,000	1...5,000 2,000	1...1,250 500	1...5,000 2,000	1...5,000 2,000
Maximum start-up torque	2018	30...90 50	30...90 50	115...35 0 190	50...240 120	50...240 120
Maximum torque	2014	30...80 40	30...80 40	115...30 0 150	50...240 100	50...240 100
Maximum holding torque at end of run	2042	0...80 30	0...80 30	0...325 120	0...200 70	0...200 70
Maximum holding torque	202B	0...60 20	0...60 20	0...245 80	0...150 50	0...150 50

Device type		PSD 424/434 - 14H	PSD 426/436 - 14H	PSD 428/438 - 14H	PSD 480/490 - 5V	PSD 480/490 - 8H/14H
Name	Index no.	Range of values Delivery state				
Upper mapping end *)	2028	388,800	256,000	196,683	806,400	806,400
Upper limit *)	2016	387,600	254,800	195,483	805,200	805,200
Lower limit *)	2017	-387,600	-254,800	-195,483	-805,200	-805,200
Target speed for positioning run	2012	1...482 100	1...317 63	1...250 50	1...800 200	1...500 200
Target speed, manual run	2013	1...482 34	1...317 22	1...250 17	1...800 70	1...500 70
Acceleration	201C	1...2,411 240	1...1,587 150	1...1,250 125	1...5,000 1000	1...5,000 1000
Deceleration	201D	1...2,411 960	1...1,587 635	1...1,250 500	1...5,000 2,000	1...5,000 2,000
Maximum start-up torque	2018	100...480 240	150...720 360	195...935 465	9...30 15	9...30 15
Maximum torque	2014	100...480 200	150...720 300	200...935 400	9...30 13	9...30 13
Maximum holding torque at end of run	2042	0...400 140	0...630 220	0...820 285	0...25 9	0...25 9
Maximum holding torque	202B	0...300 100	0...470 155	0...615 205	0...19 7	0...19 7

Device type		PSD 481/491 - 8H/14H	PSD 4212/4312 - 14H	PSD 4219/4319 - 14H	PSD 4225/4325 - 14H
Name	Index no.	Range of values Delivery state			
Upper mapping end *)	2028	198,498	118,029	77,714	59,707
Upper limit *)	2016	197,298	116,829	76,514	58,507
Lower limit *)	2017	-197,298	-116,829	-76,514	-58,507
Target speed for positioning run	2012	1...250 50	1...146 29	1...96 19	1...74 15
Target speed, manual run	2013	1...250 17	1...146 10	1...96 7	1...74 5
Acceleration	201C	1...1,250 250	1...732 73	1...482 48	1...370 37
Deceleration	201D	1...1,250 500	1...732 292	1...482 192	1...370 148
Maximum start-up torque	2018	26...120 60	307...1476 738	467...2241 1121	608...2917 1459
Maximum torque	2014	36...120 50	307...1476 615	467...2241 934	608...2917 1216
Maximum holding torque at end of run	2042	0...100 35	0...1230 430	0...1868 654	0...2431 851
Maximum holding torque		0...75 25	0...922 307	0...1401 467	0...1823 608

*) The min. and max. values for the parameters cannot be specified because they are dependent on the current scaling. The value is valid for the standard scaling (400 increments per rotation).

3.5 Process data format

3.5.1 Output module (from the perspective of the IO controller)

Bit	Byte	Meaning	Corresponding SDO index number
0-15	0-1	Control word	2024h
16-47	2-5	Target value	2001h

NOTICE

Assignment (cannot be modified)

3.5.2 Input module (from the perspective of the IO controller)

Bit	Byte	Meaning	Corresponding SDO index number
0-15	0-1	Status word	2025h
16-31	2-3	Current speed	2030h
32-63	4-7	Actual position	2003h

NOTICE

Assignment (cannot be modified)

3.6 Detailed description of status bits

Bit 0: Target position reached

This bit is set:

- when a transferred target position has been reached successfully (not at the end of a manual run, except when the target position is also the specified limit)
- as a result of manual displacement during standstill, if the actual position of the drive is once again within the positioning window
- after manual displacement while at standstill, if readjustment is activated and the absolute value of the difference of actual and target value is smaller or equal to the positioning window again.

If bit 0 is set at the same time as bit 10 (obstruction), bit 0 has priority!

This bit is reset:

- after transferring a target position when the difference from the actual value is larger than the positioning window (SDO #2006)
- by a manual run
- if an invalid target value has been transferred
- as a result of manual displacement during standstill

Bit 1: Reserved

Bit 2: Toggle Bit

This bit is set:

- when bit 13 of the control word is set

This bit is reset:

- when bit 13 of the control word is deleted

Bit 3: Reserved

Bit 4: Power supply to motor available

This bit is set:

- if the supply voltage for the motor is above the UMot limit (SDO #203C) and below the error limit (30 V up to firmware V10699; 53 V from firmware V10700)

This bit is reset:

- if the supply voltage for the motor is below the UMot limit or above the error limit (30 V up to firmware V10699; 53 V from firmware V10700)

Bit 5: Positioning run aborted

This bit is set:

- If a positioning run is aborted because the release has been withdrawn in the control word or due to an invalid bit combination in the control word

This bit is reset:

- For every new run command
- with a 0 → 1 rising edge of the bit "Error Acknowledge"

Bit 6: Drive is running

This bit is set:

- when the drive is rotating

This bit is reset:

- when the drive is at standstill

Bit 7: Temperature too high

This bit is set:

- when the internal device temperature exceeds the limit specified in SDO #203E

This bit is reset:

- when the internal device temperature falls below the limit value by 5°C (SDO #203E -5°C)

Bit 8: Run in opposite direction to loop

This bit is set:

- after power up or a reset (a lash in a driven spindle which might be present has not yet been eliminated)
- when initiating a positioning run or manual run in the opposite direction to the reference loop

This bit is reset:

- when SDO #201F=0 and a positioning run or manual run is initiated
- when a transferred target position has been reached successfully in the direction of the reference loop (not after a manual run)

Bit 9: Error bit

This bit is set:

- when an internal problem is detected when calculating the position
No run commands may be transmitted when the error bit is set!

This bit is reset:

- only possible by resetting the drive

Bit 10: Positioning error (blocking)

This bit is set:

- if a positioning or manual run is aborted because the motor stalls (blocked or binding)

If bit 0 (target position reached) is set at the same time as bit 10 (obstruction), bit 0 has priority!

This bit is reset:

- for every new run command
- with a 0 → 1 rising edge of the bit "Error Acknowledge"

Bit 11: Manual rotation

This bit is set:

- if, at a standstill, the drive is turned by an external force by more than the value in the positioning window, after a positioning run has been finished successfully

This bit is reset:

- for every new run command
- with a 0 → 1 rising edge of the bit "Error Acknowledge"

Bit 12: Incorrect target value

This bit is set:

- if a transferred target value lies outside the range limits, caused e.g. by the current reference value (SDO #2004)
- if a transferred target value lies within the range limits, but would leave the specified range during the required reference loop

This bit is reset:

- for every new run command
- with a 0 → 1 rising edge of the bit "Error Acknowledge"

Bit 13: Motor voltage was missing

This bit is set:

- if the motor voltage is below the U_{Mot} limit ... (SDO #203C) or above the error limit (30 V up to firmware V10699; 53 V from firmware V10700 when initiating a positioning run or manual run)
- if the motor voltage leaves the specified range during the run

This bit is reset:

- if the motor voltage is greater than the U_{Mot} limit and under the error limit (30 V up to firmware V10699; 53 V from firmware V10700 when initiating a positioning run or manual run)

Bit 14/ Forward/reverse limit reached

Bit 15:

This bit is set:

- if the limit value is reached during a manual run (not when reached during a positioning run)
- if an end limit is modified such that the current position lies beyond it
- if, when at a standstill, the drive is moved to a position beyond the range limits by an external force

This bit is reset:

- as soon as the drive is once again within the range limits (exception: after the end of a manual run, the drive is still at the range limit within the positioning window, and no new run command has yet been issued.)

3.7 Detailed description of control bits

Bit 0: Manual run to larger values

Bit 1: Manual run to smaller values

Bit 2: Transfer target value

When this bit is set, the target value in the process data is accepted as the new valid target value. A positioning run starting at the same time or later will use this target value as the new target position. If the positioning run is required to start as soon as the target value has been transferred, bit 4 ("release") must also be set.

If bit 2 is not set, the target value will not be accepted. Instead, a positioning run can be started to the last transmitted target value that has been marked as valid.

Bit 3: Reserved

must be set to 0

Bit 4: Release

Run commands will only be executed if this bit is set. This bit must be set for positioning runs and manual runs. If this bit is deleted during a run, the run will be aborted and status bit 5 ("Positioning run aborted") will be set.

Bit 5: Reserved

must be set to 0

Bit 6: Run without a reference loop

If this bit is set, all target positions will be approached directly during positioning runs (independently of the current value of SDO #201F), without a reference loop.

Bit 7-12: Reserved

must be set to 0

Bit 13: Toggle bit

The drive always writes this bit in status word bit 2.
→ The control unit can recognise when new process data from the drive are processed.

Bit 14: Error Acknowledge

With a 0 → 1 edge of this bit, the error bits 1, 5, 10, 11, 12 and 13 in the status byte are acknowledged

Bit 15: Reserved

must be set to 0

4 Functions

4.1 Positioning

The drive must be switched to the CN cycle state “operational” before it can be controlled using PDOs.

- Transfer target value:
PDO with control word = 0x14 and desired target value
→ drive begins to run
- Aborting a run by withdrawing release:
PDO with control word = 0x00

If a new target value is transferred during a positioning run, the device will immediately proceed to the new target. This will occur with no interruption provided the direction of rotation does not need to be altered.

If a manual run command is transmitted during a positioning run, the positioning run will be aborted (velocity will be reduced to that of a slow run) and the operator may proceed with the manual run.

The following sequence of steps is also possible:

Starting conditions: release has not been set.

- Transfer target value:
PDO with control word = 0x04 and desired target value
- Set release:
PDO with control word = 0x10
→ drive begins run

NOTICE

Positioning runs may include a “reference loop”, which ensures the target is approached from a defined direction. The direction and length of the reference loop can be set to the required value before the positioning run using SDO #201F (“length of loop”). SDO #201F can also be used to deactivate the reference loop.

NOTICE

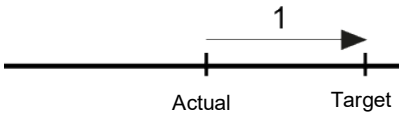
The control word and target value can only be transmitted using CN cycle state “pre-operational”.

4.2 Types of positioning

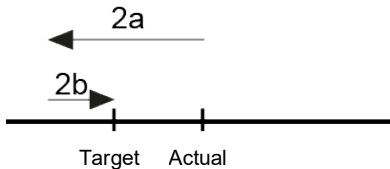
4.2.1 Positioning run *with* reference loop

The PSD4xx distinguishes between the following steps of a positioning sequence (Assumption: the target position is always approached through forward motion)

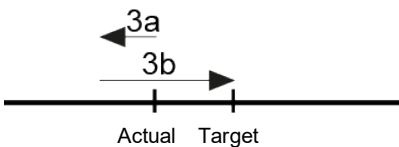
- 1) New position value is larger than the current value:
position approached directly.



- 2) New position value is smaller than the current value:
the drive reverses an additional 5/8 of one rotation (2a)
and approaches the exact position after resuming forward motion (2b).



- 3) New position value after reverse run (no reference loop):
the drive always approaches by moving forward (3b),
if necessary, it will first reverse by 5/8 of a rotation (3a).



After reaching the target position, this position is compared with the internal absolute encoder position. When positioning outside the positioning window (SDO #2006) a second positioning is automatically started and the drive will move to the target position again. If there is another deviation outside the positioning window, the status bit "Positioning error (blocking)" is set.

NOTICE

It is not possible to perform a positioning run to the upper limit (SDO #2016) with a length of loop > 0 because the drive would have to run past the upper limit in order to do so. The same applies to the lower limit (SDO #2017) with a length of loop < 0.

4.2.2 Positioning run *without* reference loop

The “positioning without a reference loop” mode is used primarily for moving the small distances involved in fine adjustments. In this case, each position is approached directly.

NOTICE

This does NOT eliminate any lash present in the driven spindle.



CAUTION!

Runs, which intentionally involve a run to an obstruction (e.g. reference runs to a block), may only be started with reduced torque (running torque to minimum value).

4.2.3 Manual run

The drive can be operated manually (so called “Manual run”). This helps to simplify start-up.

Start manual run:

- Transfer control word
PDO with control word = 0x11 and/or 0x12
→ Starts the manual run

End manual run:

- Transfer control word or reset release bit
PDO with control word = 0x10 and/or 0x00
→ Stops the manual run

NOTICE

If a positioning run is required during an active manual run, the drive must be stopped (reset the release bit). The positioning run can be initiated as soon as the drive is stationary (PDO with control word = 0x14 and the desired target value).

If pre-operational, set target value to SDO #2001. The drive then automatically deletes the manual run bits from the control word (bits 0 and 1).

4.3 Speed, Acceleration and Deceleration

Manual runs are executed using the maximum velocity from SDO #2013, positioning runs using the maximum velocity from SDO #2012.

For all runs, the maximum acceleration from SDO #201C and the maximum deceleration from SDO #201D apply.

As the drive approaches the target at the end of the run, the maximum deceleration is successively reduced in order to ensure a harmonious transient response.

If a stop command is executed, the drive brakes with the maximum possible deceleration ramp independently of the value in SDO #201D.

4.4 Maximum start-up and operating torque

The maximum start-up torque can be set using SDO #2018, the maximum operating torque using SDO #2014.

The start-up torque is active after each run begins for the period defined in SDO #2019.

NOTICE

The stepper motor is optimized for maximum torque. If the PSD is operated at speeds above 400 1/min, self-resonance or even self-locking occurs. Just by adding an inert mass, the natural resonance is significantly damped!

NOTICE

The start-up torque should always be slightly higher than the operating torque because the drive requires more power during the acceleration phase compared to a state of constant velocity

NOTICE

If small torque limits are to be used, the following must be considered: Small operating torque values should not be used in combination with high speed settings as this can lead to instability!

4.5 How to respond if the drive encounters an obstruction (blocking)

If an obstruction (block) is detected, the run is aborted and the "Positioning error" bit is set. The PSD4xx now operates with the specified maximum holding torque (SDO #202B).

After this, new run commands can be sent without taking further measures, i.e. transferring a new target position (changing the value of the target position in the process data) starts a new positioning run.

Exception:

The exception to this is if the target value is the same as before. In this case, cancel the release and reset it (bit 4 in the control word). Bit 2 ("Transfer target value") must be set in this case. The drive then begins a new positioning run.



CAUTION!

Runs which intentionally involve a run to an obstruction (e.g. reference runs to a block) may only be started with a reduced torque (max. operating torque < 10 % of nominal rated current or smallest possible value).

4.6 How to respond if drive is turned manually (adjustment function)

If the PSD4xx is rotated in the opposite direction from the reference loop – when at a standstill, after a correctly completed positioning run and the release bit (bit 4 in the control word) as well as the readjustment bit (SDO #2047) are activated – it will again attempt to run to the previously sent target value (adjustment). After successful readjustment bit 0 will be set again.

The device does not attempt to adjust if rotated in the direction of the reference loop, it will merely set bit 11 of the status word (“Manual rotation”) and reset bit 0 (“Target position reached”). If the reference loop is deactivated (SDO #201F = 0), the drive will adjust in both directions.

NOTICE

The device does not attempt to adjust if rotated in the direction of the reference loop, it will merely set bit 11 of the status word (“Manual rotation”) and reset bit 0 (“Target position reached”).

NOTICE

If the drive continually loses its position at a standstill, it will attempt to adjust whenever its actual position just leaves the positioning window (provided that all of the above-mentioned conditions are met). At this time, the motor voltage must be within the permissible range (i.e. bit 4 is set in the status word).

No adjustment will start if the motor voltage is not in the permissible range. Instead, bit 10 (“Positioning error”) and bit 13 (“Power was unavailable to motor”) will be activated.

If the motor voltage only returns to the permissible range after leaving the positioning window, no new adjustment attempt will start. This prevents a situation in which the drive suddenly starts to move when the motor voltage is switched on.

If a positioning run or manual run is aborted while in progress by a stop command (“Release” bit in control word to 0), the drive will only adjust when a new run command is sent and completed correctly.

Deleting the release bit and/or adjustment function can completely prevent the adjustment process.

4.7 Calculate the absolute physical position

The PSD4xx actuator includes an absolute measuring system capable of covering a range of 4,026 rotations (with 400 steps per rotation). This allows the user to determine the direction of rotation for any desired portion of these 4,026 rotations.

The mapping of the desired positioning range to the physical positioning range “mapping end” is performed via SDO #2028.

In the delivery state, the drive is positioned at 0, the upper limit is 805,200, the lower limit is - 805,200. This results in a positioning range of $\pm 2,013$ rotations ($\pm 805,200$ steps). If the desired positioning range does not exceed $\pm 2,013$ rotations, none of the steps described below are required to set the positioning range in the delivery state.

The following two options are available to allow you to realise any desired positioning run distances independently of the run distance set by the mounting orientation of the measurement system (physical positioning range):

- 1) Bring the axle to be moved (e.g. a spindle) into the desired position, run the drive to the appropriate position with the adjustable collar open and only then close the adjustable collar.

Examples:

- a) Bring the axle to be positioned into the mid-position, run the drive in neutral (with the adjustable collar open) to the mid-position (position 0), then close the adjustable collar. The drive can now run 2,013 rotations in both directions (default $\pm 805,200$ increments).
- b) Bring the axle to be positioned all the way to the left (or bottom), run the drive in neutral (with the adjustable collar open) without a loop to the smallest position (position - 805,200), then close the adjustable collar. The drive can now run 4,026 rotations to the right (or top) (default 1,610,400 increments).
- c) Bring the axle to be positioned all the way to the right (or top), run the drive in neutral (with the adjustable collar open) to the largest position (position 805,200), then close the adjustable collar. The drive can now run 4,026 rotations to the left (or bottom) (default 1,610,400 increments).

- 2) Mount the drive in the required position on the axle, close the adjustable collar, then adjust the positioning range using SDO #2028. SDO #2028 sets the upper end of the positioning range. Default setting: upper end at +2,016 rotations (position 806,400). If, after mounting the drive, the positioning range does not match the currently displayed position, you can select the positioning range between + 3 ... +4,029 rotations.

Examples:

- a) After mounting the drive, the position 0 is displayed (which corresponds to the delivery state). The positioning range should point exclusively to the right (or top)
 - Upper mapping end = Position +4,029 rotations
 - Set SDO #2028 to 1,611,600.
- b) After assembly, the displayed position is 804,000. However, the positioning range should point exclusively to the right (or top)
 - Upper mapping end = Position +4,029 rotations
 - Set SDO #2028 to 2,415,600.
- c) After assembly, the displayed position is -804,400. However, the positioning range should point exclusively to the left (or bottom)
 - Upper mapping end = Position +3 rotations
 - Set SDO #2028 to -803,200.

Notes:

- 1) When calculating the upper mapping end (SDO #2028) (as in the above examples), it is essential to include a safety margin of 3 rotations (by default 1,200 increments), because the highest possible position value is 3 rotations below the upper mapping end. The smallest possible position value is 4,029 rotations below the upper mapping end.
- 2) The numbers of increments or position values indicated relate to the following settings, which correspond to the delivery state:
 - a) Reference value (SDO #2004) = 0
 - b) Position scaling, numerator (SDO #2010) = 400
 - c) Position scaling, denominator (SDO #2011) = 400

These 3 parameters affect the above numbers of increments or position values: The reference value can be used to shift the range of values, the numerator/denominator to stretch or extend the range of values (see below).

- 3) If the direction of rotation is changed (SDO #202C), the reference value (SDO #2004), the upper mapping end (SDO #2028) and the upper and lower limits (SDO #2016 and #2017) will be reset to the delivery states.
- 4) When the upper mapping end is changed (SDO #2028), the upper and lower limits (SDO #2016) will be reset to the delivery states.
- 5) If the positioning scaling is changed (numerator: SDO #2010 or denominator: SDO #2011), the target value, actual value, reference value, upper mapping end and the upper and lower limits, positioning window and length of loop will be recalculated.

- 6) If the reference value is changed (SDO #2004), the target value, actual value, upper mapping end and the upper and lower limits will be recalculated.
- 7) If the user wants to avoid any automatic adjustment of values when setting the parameters for the drive, the optimum order for sending the parameters is as follows:
 - a) Direction of rotation (SDO #202C)
Positioning scaling, numerator (SDO #2010)
Positioning scaling, denominator (SDO #2011)
 - b) Reference value (SDO #2004)
 - c) Upper mapping end (SDO #2028)
 - d) Positioning window (SDO #2006)
Length of loop (SDO #201F)
- 8) To save the settings permanently in EEPROM write a 1 in SDO #204F.
Saving can take up to 1 second.

Reference value (SDO #2004):

The referencing process affects all transferred values, i.e., the target value, actual value, upper mapping end and upper and lower limits.

There are two ways of setting the referencing value:

- 1) Directly – by writing the referencing value in SDO #2004.
- 2) Indirectly – by writing an actual value to SDO #2003. This makes it possible to assign any “true” actual value to the current, physical actual value. The resulting difference is then the referencing value. This value will immediately be included in calculations for each transferred value and can also be read under SDO #2004.

If the reference value is changed, the target value, actual value, upper mapping end and the upper and lower limits will be recalculated.

NOTICE

Removal of the supply voltage to the **motor** has no effect on the internal measurement system.

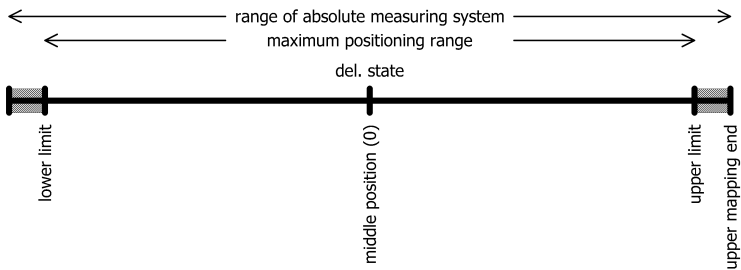
4.8 Use of the “Upper mapping end” parameter

The following chapter illustrates the use of the parameter “upper mapping end” both graphically and by means of examples:

a) Delivery state

In the delivery state (“DS”), the actual position is exactly in the middle of the positioning range. There is a safety margin of three rotations at the output shaft at both the lower and upper ends of the positioning range.

Positioning runs that extend into these safety margins are rejected by the device with the error “Incorrect target value”.



In the delivery state, the values from the following table result for the upper mapping end and the lower and upper limits:

Device type	PSD 401/411, 422/432, 480/490	PSD 403/413, 481/491	PSD 424/434	PSD 426/436	PSD 428/438
Measurement range of the absolute measuring system	4,032 rotations	992 rotations	1,944 rotations	1,280 rotations	983 rotations
Max. possible positioning range	4,026 rotations	986 rotations	1,938 rotations	1,274 rotations	977 rotations
Upper mapping end	806,400	198,498	388,800	256,000	196,683
Lower limit	-805,200	-197,298	-387,600	-254,800	-195,483
Upper limit	805,200	197,298	387,600	254,800	195,483

Positioning range symmetrical to 0

Device type	PSD 4212/ 4312	PSD 4219/ 4319	PSD 4225/ 4325
Measurement range of the absolute measuring system	590 rotations	388 rotations	298 rotations
Max. possible positioning range	584 rotations	382 rotations	292 rotations
Upper mapping end	118,029	77,714	59,707
Lower limit	-116,829	-76,514	-58,507
Upper limit	116,829	76,514	58,507

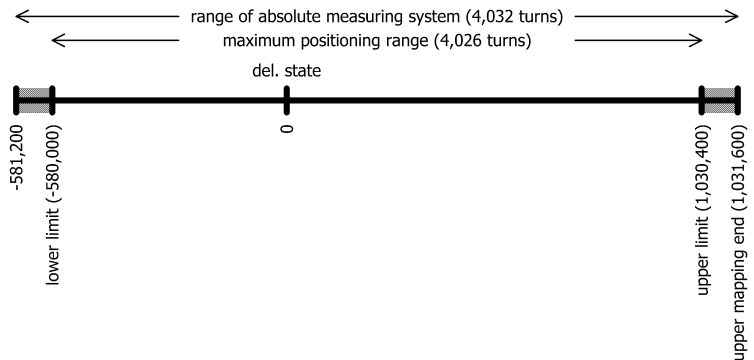
Positioning range symmetrical to 0

Starting from this state, the maximum possible positioning range can now be shifted upwards or downwards as required.

It is important to note that after the device has been installed, the available positioning range may not be sufficient in one of the two directions. The parameter “upper mapping end” now allows you to reduce the positioning range in one direction and increase it in the other direction.

b) Shifting the positioning range upwards starting from the delivery state

In the following example, starting from the DS, the maximum possible positioning range is shifted slightly **upwards** using the parameter “upper mapping end” (example for a PSD401/411, PSD422/432 or PSD480/490):



Here, the upper mapping end was increased from the value 806,400 to 1,031,600. Consequently, a higher proportion of the possible positioning range is in the positive range and a smaller proportion in the negative range.

In the extreme case, the upper mapping end can be set so that the entire possible positioning range is at values ≥ 0 . With standard scaling (numerator = denominator = 400, i.e. 1 step = 0.9°)

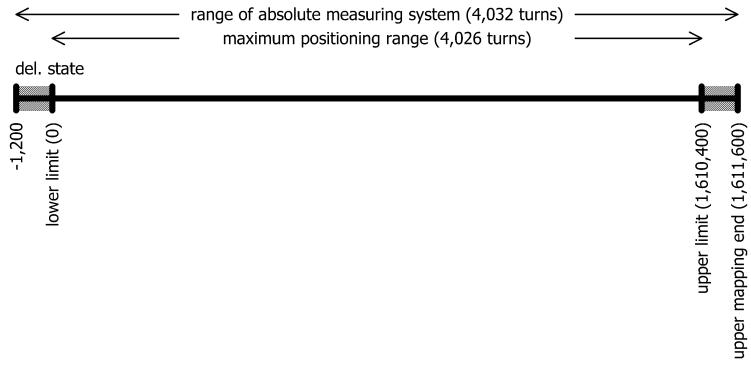
and referencing value = 0, this special case results if the relevant value from the following table is selected for the upper mapping end. The device then automatically adjusts the lower and upper limits accordingly.

Device type	PSD 401/411, 422/432, 480/490	PSD 403/413, 481/491	PSD 424/434	PSD 426/436	PSD 428/438
Measurement range of the absolute measuring system	4,032 rotations	992 rotations	1,944 rotations	1,280 rotations	983 rotations
Max. possible positioning range	4,026 rotations	986 rotations	1,938 rotations	1,274 rotations	977 rotations
Upper mapping end	1,611,600	395,796	776,400	510,800	392,166
Lower limit	0	0	0	0	0
Upper limit	1,610,400	394,596	775,200	509,600	390,966

Positioning range starts at 0

Device type	PSD 4212/ 4312	PSD 4219/ 4319	PSD 4225/ 4325
Measurement range of the absolute measuring system	590 rotations	388 rotations	298 rotations
Max. possible positioning range	584 rotations	382 rotations	292 rotations
Upper mapping end	234,858	154,228	118,214
Lower limit	0	0	0
Upper limit	233,658	153,028	117,014

Illustration of this extreme case for a PSD401/411, PSD422/432 or PSD480/490:

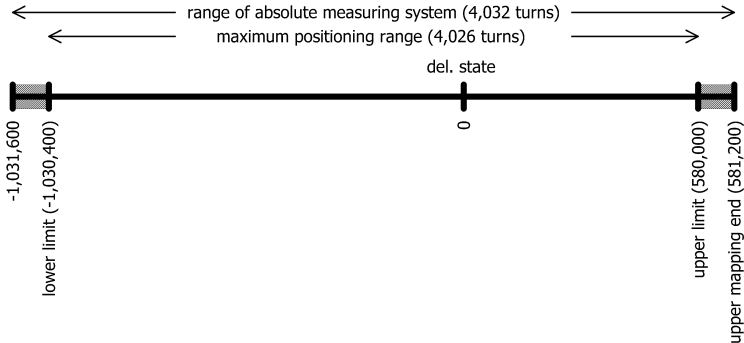


NOTICE

The numerator factor and denominator factor can be used to map any spindle resolutions. Using the referencing value, you can shift the whole range of values.

c) Shifting the positioning range downwards starting from the delivery state

In the following example, starting from the DS, the maximum possible positioning range is shifted slightly **downwards** using the parameter “upper mapping end” (example for a PSD401/411, PSD422/432 or PSD480/490):



Here, the upper mapping end was decreased from the value 806,400 to 581,200. Consequently, a higher proportion of the possible positioning range is in the negative range and a smaller proportion in the positive range.

In the extreme case, the upper mapping end can be set so that the entire possible positioning range is at values ≤ 0 . With standard scaling (numerator = denominator = 400, i.e. 1 step = 0.9°) and referencing value = 0, this special case results if the relevant value from the following table is selected for the upper mapping end. The device then automatically adjusts the lower and upper limits accordingly.

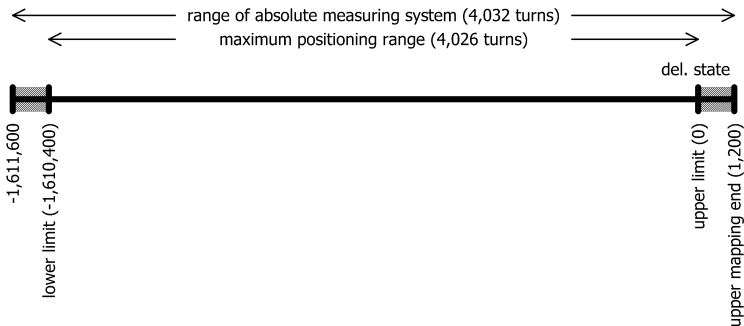
Device type	PSD 401/411, 422/432, 480/490	PSD 403/413, 481/491	PSD 424/434	PSD 426/436	PSD 428/438
Measurement range of the absolute measuring system	4,032 rotations	992 rotations	1,944 rotations	1,280 rotations	983 rotations
Max. possible positioning range	4,026 rotations	986 rotations	1,938 rotations	1,274 rotations	977 rotations
Upper mapping end	1,200	1,200	1,200	1,200	1,200
Lower limit	-1,610,400	-394,596	-775,200	-509,600	-390,966
Upper limit	0	0	0	0	0

Positioning range ends at 0

Device type	PSD 4212/ 4312	PSD 4219/ 4319	PSD 4225/ 4325
Measurement range of the absolute measuring system	590 rotations	388 rotations	298 rotations
Max. possible positioning range	584 rotations	382 rotations	292 rotations
Upper mapping end	1,200	1,200	1,200
Lower limit	-233,658	-153,028	-117,014
Upper limit	0	0	0

Positioning range ends at 0

Illustration of this extreme case for a PSD401/411, PSD422/432 or PSD480/490:



d) Shifting the positioning range depending on the actual position

If (in contrast to the examples above) the actual position is not in the delivery state (i.e. value 0), this is included in the calculation of the possible value range for the upper mapping end. The decisive factor is that the device only accepts values for the upper mapping end where the actual position is within the max. possible positioning range after the upper mapping end has been set (due to rounding effects with a max. difference of 1 step), i.e. the following applies after setting the upper mapping end:

$$[\text{lower limit} - 1] \leq \text{actual position} \leq [\text{upper limit} + 1]$$

Please note that the measurement range of the absolute encoder is 4,032 rotations at the motor shaft. Depending on the ratio of the auxiliary gearbox, the measurement range at the output shaft is reduced accordingly. Together with the safety margins at the upper and lower end of the measurement range, the following value ranges result for the upper mapping end:

$$\begin{aligned} \text{Minimum value for upper mapping end} &= \text{actual position} + 1200 * \text{denominator} / \text{numerator} \\ \text{Maximum value for upper mapping end} &= \text{actual position} + a * \text{denominator} / \text{numerator} \end{aligned}$$

The variable a differs between the individual device variants:

Device type	PSD 401/411, 422/432, 480/490	PSD 403/413, 481/491	PSD 424/434	PSD 426/436	PSD 428/438
Variable a	1,611,600	395,796	776,400	510,800	392,166

Device type	PSD 4212/ 4312	PSD 4219/ 4319	PSD 4225/ 4325
Variable a	234,858	154,228	118,214

The following formulas result for the special case numerator = denominator:

$$\begin{aligned} \text{Minimum value for upper mapping end} &= \text{actual position} + 1200 \\ \text{Maximum value for upper mapping end} &= \text{actual position} + a \end{aligned}$$

(This is the case, e.g. for the delivery state where numerator = denominator = 400.)

NOTICE

Since the upper mapping end is an integer, the minimum and maximum values are obtained by rounding to the nearest integer (applies only to the case numerator \neq denominator).

Example:

- Spindle with 5 mm pitch, specified unit for target and actual values: 1 μm
 → 1 rotation = 5 mm = 5,000 μm
 → Number of steps per rotation = 5,000
- Using the formula

$$\text{Number of steps per rotation} = 400 * \text{denominator} / \text{numerator}$$
 the following result is obtained:
 numerator = 400; denominator = 5,000
- With these settings, the drive is mounted and run using manual positioning commands, to a defined physical position (e.g. a specific mark along the run path) at which the actual position is to assume a specific value, e.g. the value 0.
- In our case, the position after running to this defined physical position shows, for example, the value 300,000. In this position, the actual value is set to zero. The device uses this information to calculate the new referencing value at 300,000.
 → Referencing value = 300,000
- The drive (in our case a PSD401, PSD411, PSD422, PSD432, PSD480 or PSD490) has a positioning range of 4,026 rotations (see above: Measurement range of the absolute encoder minus a safety margin of three rotations at both ends of the measurement range).
- In our case, these 4,026 rotations are to be divided in such a way that the drive can run 10 rotations (= 10 * 5,000 steps = 50,000 steps) from the zero position, just defined, to smaller values and 4,016 rotations (= 4,016 * 5,000 steps = 20,080,000 steps) to larger values.
- To ensure that the position value 20,080,000 is at the upper end of the maximum possible positioning range, as specified (i.e. at the upper limit), we add the safety margin of three rotations to this value and thus obtain our value for the upper mapping end:
 upper mapping end = 20,080,000 + 3 * 5,000 = 20,095,000
- The device then recalculates the positioning range limits:
 lower limit = upper mapping end - 4,029 * 5,000 = -50,000
 upper limit = upper mapping end - 3 * 5,000 = 20,080,000
- This positioning range can then be restricted as required, i.e. the lower limit can be increased and the upper limit can be reduced.

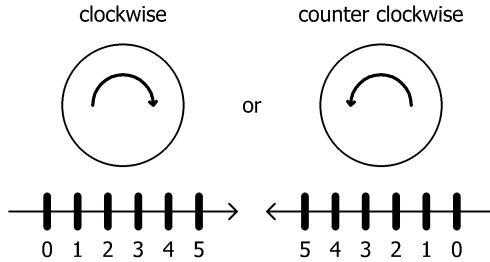
e) Step-by-step instructions for determining the positioning range

The following section describes the procedure for determining those parameters that have an influence on the target and actual position as well as the positioning range.

The individual steps must be carried out in the specified order.

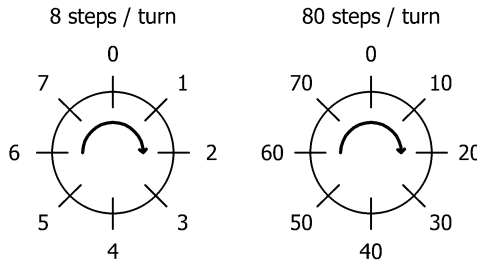
1) Setting the direction of rotation:

The direction of rotation determines with which direction of rotation of the output shaft the position values increase and with which direction of rotation of the output shaft the position values decrease.



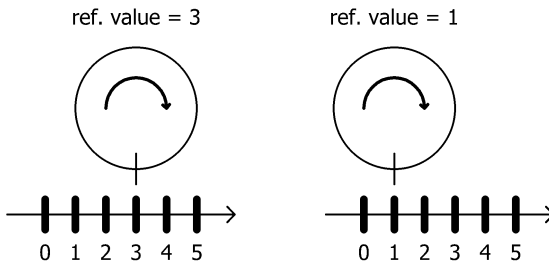
2) Setting numerator and denominator:

The numerator and denominator determine the number of steps into which one rotation of the output shaft is divided.



3) Setting referencing value:

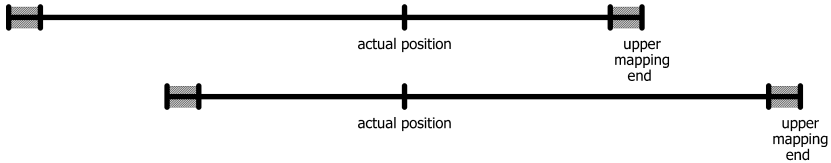
The referencing value is used to assign a specific value of the actual position to a specific physical position of the axle.



The referencing value is written either directly or by setting the actual position.

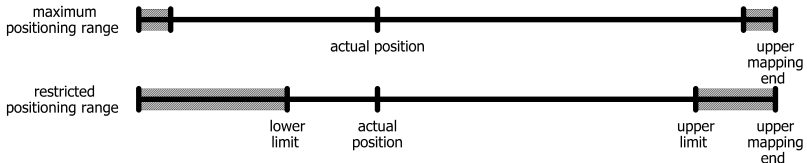
4) Setting upper mapping end:

The parameter defines the location of the maximum possible positioning range in relation to the actual position.



5) Setting upper and lower limits:

If necessary, the maximum possible positioning range can be restricted to prevent incorrect target positions that lead to a collision.



4.9 Set the spindle pitch

Using SDO #2010 (numerator factor) and SDO #2011 (denominator factor), it is possible to represent any desired spindle pitch using positioning scaling factors:

$$\text{Number of increments per rotation} = 400 \times \frac{\text{Denominator factor}}{\text{Numerator factor}}$$

Both factors are set to a value of 400 by default, resulting in a resolution of 0.01 mm at a spindle pitch of 4 mm.

The denominator factor serves as a simple means of setting the spindle pitch and resolution.

The numerator factor is primarily used for setting “uneven” resolutions.

Examples:

Spindle pitch	Resolution	Numerator factor	Denominator factor
4 mm	1/100 mm	400	400
1 mm	1/100 mm	400	100
2 mm	1/10 mm	400	20

NOTICE

Numerator and denominator factors may take on values between 1 and 10,000

4.10 Abort the run when the master fails

If the connection to the Powerlink master is interrupted during a positioning run, the master cannot abort a run that has already begun. To trigger an automatic movement abort in this case, for example, the drive includes a timeout monitor for communication with the Powerlink master: If the drive does not receive a sync event within the specified time, it diagnoses a connection failure. The drive aborts the motion and cannot start a new positioning operation until a connection is reestablished.

4.11 Reference runs

The PSD4xx positioning system is equipped with an absolute measuring system, so no reference run is required when the drive is switched on. If a reference run should be required to a hard obstruction in a specific instance (e.g. once during installation of the drive on a machine), the procedure should be as follows:

- 1) Prior to ordering the reference run, adjust the settings as follows:
 - a) Set max. operating torque (SDO #2014) and max. start-up torque (SDO #2018) to 10 % of the max. value, resp. the lowest possible values.
 - b) Set max. holding torque (SDO #202B) and max. holding torque at the end of the run (SDO #2042) to 0.
 - c) Set the speed limit (1/min) for aborting run (SDO #201A) to 60.
 - d) Set the time elapsed until falls below speed limit for aborting run (SDO #201B) to 100. (The time during which the drive tries to overcome the obstruction decreases: with these reduced values, the positioning run is aborted if the speed (1/min) remains below 60 % of the target speed for longer than 100 ms. The default settings are 200 ms and 30 %.)
 - e) Set the affected end limit (SDO #2016 or SDO #2017) so that the obstruction is clearly within the limit in each case. (Otherwise, there is a risk that the obstruction will lie within the positioning window and therefore not be recognised.)
 - f) If necessary, reduce the target speed for manual operation (SDO #2013)
- 2) Now start the reference run as a manual run (bit 0 or 1 in the control word).
- 3) Wait until the drive is running (bit 6 is set in the status word)
- 4) Wait until the drive is stationary and a positioning error has occurred (bit 6 of the status word is reset, bit 10 is set).
- 5) Using the same settings, perform a manual run in the opposite direction (move a little distance away from the obstruction so the drive can move freely).
- 6) Only now use desired settings for normal operation of the above SDOs.

4.12 Modulo Function

The modulo mode is only available for variants with the “Software modules” = “M” or “Z”

Operating principle:

The modulo function allows the user to have the device process the transmitted target position as a modulo position instead of as a continuous target position. This can be used to cover applications in which, for example, it is driving a **turntable**.

The user specifies a range for target and actual values, as in normal operation. In modulo mode, the limits of this range are called “Lower modulo position” or “Upper modulo position”. The special feature of the modulo mode is that the modulo range repeats infinitely upwards and downwards, i.e. in this operating mode there are no limits to the positioning range – thus it is possible to make an infinite number of positioning runs in the same direction.

A characteristic feature of these applications is that after a certain distance, the entire arrangement is back in its initial state. e.g. for a turntable, where the axle is driven directly (i.e. without a gearbox), this would be the case after exactly one turn of the turntable.

The distance after which the arrangement is back in the initial state is called the “modulo width”. The modulo width is determined by specifying the parameters “Upper modulo position” and “Lower modulo position”:

$$\text{Modulo width} = \text{Upper modulo position} - \text{Lower modulo position}$$

The modulo mode distinguishes between five sub-modes; the following parameters are therefore relevant for the modulo function:

- 1) Modulo mode (SDO #2053)
- 2) Upper modulo position (SDO #2054)
- 3) Lower modulo position (SDO #2055)

Processing the target position in modulo mode:

When the modulo function is activated, the target position is placed in the modulo range – taking into account the modulo width – in such a way that the difference between the transmitted target position and the position actually approached is an integer multiple of the modulo width.

Example:

- Upper modulo position = 360 (SDO #2054)
- Lower Modulo position = 0 (SDO #2055)
- Transmitted target position = 450 → Device runs to position 90.

Calculation of the actual position:

Likewise, the device outputs the actual position so that the value is always within the modulo range:

$$\text{Lower modulo position} \leq \text{Actual position} < \text{Upper modulo position}$$

The following rules apply:

- When the value for the actual position increases, the actual position jumps to the value "Lower modulo position" as soon as the value [Upper modulo position - 1] is exceeded.
- When the value for the actual position decreases, the actual position jumps to the value [Upper modulo position - 1] as soon as the value falls below the value "Lower modulo position".

Activation of modulo mode:

Modulo mode is activated or deactivated by setting SDO #2053 ("Modulo mode"). The parameter can assume the following states:

- 0 → Modulo function inactive (this is the default value)
The transferred target position is processed as a continuous target position.
- 1 → Run to larger values
In this mode, the device runs exclusively in the direction of larger values.

When the value [Upper modulo position - 1] is exceeded, the actual value jumps to the value [Lower modulo position]. The maximum run distance corresponds to the distance [Modulo width - 1].
- 2 → Run to smaller values
In this mode, the device runs exclusively in the direction of smaller values.

When the value falls below the value [Lower modulo position], the actual value jumps to the value [Upper modulo position - 1]. The maximum run distance corresponds to the distance [Modulo width - 1].
- 3 → Shortest distance
In this mode, the device selects the direction required to run to the specified target position by the shortest distance. The maximum run distance corresponds to the half modulo width.
- 4 → Run to larger values, with blocking zone
This mode is the same as the "Run to larger values" mode with the following exception: if the distance of a run is smaller than or equal to the positioning window when moving to smaller values, the drive runs to the desired target position at smaller values.
- 5 → Run to smaller values, with blocking zone
This mode is the same as the "Run to smaller values" mode with the following exception: if the distance of a run is smaller than or equal to the positioning window when moving to larger values, the drive runs to the desired target position at larger values.

NOTICE

Modes 4 and 5 are useful when a new run command to the actual position is issued. In contrast to modes 1 and 2, a slight drifting of the actual position in these modes does not lead to an unintended run by almost a whole modulo width

Other settings:

The other settings that influence the positioning process (in particular, the direction of rotation, scaling, referencing value, positioning window and activation of the adjustment function) retain their previous function in modulo mode, but the following exceptions apply:

- The positioning range limits and the upper mapping end have no function in modulo mode.
- In modulo mode, there is generally no reference loop. However, the sign of the loop length (SDO #201F) also defines the direction from which adjustment is performed in modulo mode.

Manual run in modulo mode:

When modulo mode is activated (i.e. modulo mode > 0), the drive moves exactly one modulo width starting from the actual position. This applies regardless of the direction specified by the modulo operating mode:

- Manual run to larger values → The drive runs one modulo width to larger values.
- Manual run to smaller values → The drive runs one modulo width to smaller values.

NOTICE

The SDOs #2053...#2056 are available from firmware V1.5.20. For variants with the "Modulo function" option (i.e. variants with the feature "Software modules" = "M" or "Z"), the modulo function is configured with these SDOs. For variants without the "Modulo function" (i.e. variants with the feature "Software modules" = "1", "S" or "P"), only the default value can be written, other values are rejected

4.13 Run drive in reverse

Depending on the model, the drive may be run in reverse up to a certain speed.



CAUTION!

Running a PSD4xx in reverse for more than 1-2 seconds at more than the permissible speed will damage the internal protection diode and the PSD4xx will be defective.

Please refer to the following table to find the maximum permissible speed:

Device model	PSD 401/411 - 5V/8H/14H	PSD 403/413 - 8H/14H	PSD 422/432 - 8V/8H/14H	PSD 424/434 - 14H	PSD 426/436 - 14H	PSD 428/438 - 14H
Max. permissible speed [1/min]	200	48	200	95	60	45

Device model	PSD 480/490 - 5V	PSD 480/490 - 8H/14H	PSD 481/491 - 8H/14H	PSD 4212/4312 - 14H	PSD 4219/4319 - 14H	PSD 4225/4325 - 14H
Max. permissible speed [1/min]	200	200	48	29	19	15

5 Technical data

Technical data and drawings can be found in the current data sheet on the website:
www.halstrup-walcher.de/technicaldocu

Please search for "PSD" and select your type, click on "Data sheets".

Please contact us if you require any further information.

6 Notes

